

Climate Change and Dynamics of Northern Hardwood Forests in the Upper Great Lakes Region

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Introduction

Over the last century the average temperature of the Earth's surface has increased by 0.74°C and will continue to rise by 1.5-4.5°C by 2050. Over the Great Lakes Region, climate models predict an augmentation in temperature by 3 to 7°C in winter and by 3 to 11°C in summer by the end of the century. Precipitation is projected to rise in the winter and decrease in the summer, and the region may become drier overall because of future increased evaporation and transpiration that exceed surpluses of precipitation.



As a result of a warming climate, species ranges are predicted to shift to the north and the prairie-forest border may also move to the northeast. The northern hardwoods (sugar maple, yellow birch, basswood, and hemlock) may be replaced by oak savanna and/or prairies at the prairie-forest border resulting in the largest deforestation event since European settlement, whereas at the northern edge of their range they may replace conifers. Climate change may also increase the size and severity of windstorms (e.g. derechos) and therefore cause significant damage to the Upper Great Lake forests. This may directly impact forest composition and Downed Woody Material (DWM) dynamics, and indirectly affect forest carbon pools and natural fire regimes across the region.

Research Hypotheses

- 1) Dieback, tree mortality and regeneration failure are more concentrated on sites with relatively sandy or shallow soil and near the prairie-forest border.
- 2) Northern hardwood species are expanding their niche as indicated by lower mortality and more successful regeneration in the north where the northern hardwoods intermingle with the boreal forest (i.e. northeastern MN and parts of Upper Michigan).
- 3) Large-scale forest blowdowns are changing DWM distributions and facilitating changes in species composition to species adapted to warmer climate.

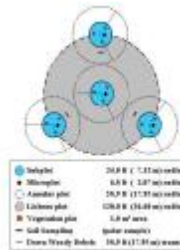


Figure 1. FIA data plots (Phases 2 & 3) will be used for this study. Permanent ground plots are one plot per 6,000 acres (Betcholdt and Patterson 2005).



Objectives

1. Determine health of northern hardwood forest ecosystems (sugar maple, yellow birch, basswood, with some red oak and hemlock) as affected by early stages of global warming.
2. Study the regeneration dynamics of the northern hardwoods at the northern edge of their range.
3. Investigate forest dynamics in response to large-scale wind events (derechos).

Methods

Objectives 1 and 2: We will examine the region-wide spatial patterns of regeneration abundance, crown dieback, and comparison of species composition of regeneration and overstory of the northern hardwoods from Forest Inventory Analysis (FIA) data, also taking into account site variables such as soil texture, depth, slope, and aspect. Exact coordinates of FIA plots are not necessary given the regional scope and fact that site variables are attached to each FIA plot. A variety of spatial statistics, multiple regression, logistic regression techniques, as well as multivariate analyses such as ordination and classification will be used, similar to a number of previously published papers by Frelich and collaborators.

Objective 3: In this study region, FIA DWM data is currently available for measurement years 2003-2006, within the next 9 months additional years will become available to this study (2001-2002, 2007). We will relate DWM variables to known occurrences of major windstorms from the National Weather Service Storm Report database, and also to composition of the downed material/remnant overstory trees and regeneration, and as with objectives 1 and 2, provide a regional spatial analysis.

Implications and Conclusion

- Foresters have reported patchy dieback on mature tree crowns and regeneration failures throughout the northern hardwood forests of the Upper Great Lakes. Results from this study will allow us to describe current patterns of these forests.
- Changes in the northern hardwoods forests can generate cascading effects throughout the ecosystem and economy of the region. Wildlife populations and timber production could be dramatically impacted by the decline in health or changes in composition of the existing forests.
- Because of the current rapidly changing environment, it is critical to monitor current conditions of these forests and detect changes and trends.

Selected References

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